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ABSTRACT

This script for a slide and audiocassette presentation/training module is designed for photographers in the criminal justice system. The instructions for using the three-dimensional evidence mapping cube may also be relevant to those in the industrial technology field. Discussion first centers on illustrating (by photography) two-dimensional evidence. Next, the evidence mapping cube (EMC) is proposed as a way to provide a scale-reference in the three primary dimensions. Proper arrangement of the EMC and proper illumination of the subject are emphasized and described. The order of slides is included for reference. (YLB)

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SCRIPT

THREE-DIMENSIONAL EVIDENCE MAPPING CUBE

(A Photography Training Module)

Project No. 85-131/132-600-10(122-122)(B)

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1PHOTOGRAPHING EVIDENCE

The following presentation has been prepared for photographers in the criminal justice system. The information may also be relavent to those in the industrial technology field.

It is presumed that the learner can operate an adjustable 35 mm camera and has access to two small spotlights or projectors. Computations of area or volumes will utilize the following symbols: l=length; w=width; h=height; r=radius; ii=pi(3.14).

Before beginning, please check to see that the slides are in correct order and will synchronize with the audio cassette--according to the script provided. The simulation model should be assembled and within reach of the learner. The learner should provide a couple of simple geometric objects like a cup or can to represent a cylinder, and a small box to represent a rectangular cube.

STOP THE TAPE UNTIL READY TO BEGIN INSTRUCTION.....

We perceive the physical world in three dimensions and while we would like to present the actual objecat as evidence in court, it is more practical to use photographs as they can be reproduced in quantity; are filed easily; and they may illustrate characteristics difficult to see by the naked eye. The use of pictures further protects the origional object from deterioration and unnecessary handling.

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The photograph, however, is a two-dimensional medium while evidence may be either two-dimensional or three-dimensional.

A selective angle may provide a reference to the shape of the object; selective lighting provides texture and detail; and a scale will provide a reference to the object size.

As seen here, the oval box lacks a scale, such that the viewer must depend upon familiarity to estimate the subject size and/or it's distance from the camera.

Is this the same oval box at a greater distance--or, is this a smaller box presented at the same camera distance?

Typically, evidence is depicted with a ruler in the field of view. The ruler does give us a reference to size--but to what degree is it of benefit? The foreground scale is inadequate to determine the depth or the narrow dimension of the oval, as they are not in the same plane as the ruler.

In this visual, we are better able to observe a measurement in any of three dimensions and see side and end silloette views as well as the detailed isometric view.

By far, the easiest evidence to represent is the two-dimensional subject. It has only length and width and though its depth may be measureable it will not be considered signifigant. The film plane must be parallel with the subject and the scale device may appear anywhere in

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the field of view to be relavent throghout the image. Any known standard of reference may be substituted for a ruler. Frequently graph paper is used to provide a coordinate system of illustration, but even a coin can be used as a scale reference. Lighting may be soft and even as for these images or where texture is signifigant "side lighting" can be used to exaggerate scratches across the two elements of a broken knife blade.

Knowing the two-dimensional measures within the illustration allows the viewer to apply simple math to calculate the circumference of a circle(2*ii*r); the area of a circle(ii*r2), or perhaps the area of a rectangle(l*w).

A traffic accident scene or perhaps a crime scene may be considered to be a reasonably flat field--or two-dimensional

subject, but seen at oblique angles(unless an aerial photo is possible). In such cases as these the camera cannot practically be placed directly over the subject area. Under such circumstances as these, a square reference card may be placed on the flat area in the scene pictured. Extending lines on the grid to the three natural vanishing points at infinity on the horizon will create a checkerboard appearance across the image with distortion consistant with the perspective. Carefully drawn, an accurate overhead map of the scene may be constructed and objects in the picture can be placed in their proper relationship to each other. This process is reffered to as "photogrametry", as developed

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for the criminal justice system in 1964 by J. Stannard Baker.

As mentioned, two-dimensional evidence can be illustrated with a reasonable degree of fairness and accuracy. Providing the same fairness and accuracy for three-dimensional evidence has remained a problem for the photographer for many years. In lieu of the actual object, many images may tell the story, or unique multiple projections of images to create a "3-D effect have been used. In most cases three-dimensional evidence is misrepresented and photographed by one of the preceeding methods already described.

The evidence Mapping Cube(EMC) is designed to provide a scale reference in the three primary dimensions. axial lights provide flat shadow silloettes on the two walls, and the selected camera angle and perspective provides an isometric view that shows the detail and form of the object in a graphic display requiring no drawing on the photograph or scale adjustments, and there is no experience needed to interpret the information in the visual presentation.

Whether the object is familiar or unknown, a brief look at an EMC illustration quickly acquaints the viewer with the subject--in a single illustration.

Imagine if you will these three geometric figures and three dimensional objects that they might represent. The square might be flat or perhaps a short cube or long cube. The circle might be a disc, or a cylinder of any length, or

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even a round ball. The triangle might be flat, or a wedge of any length or even a pyramid. All of the figures have an ambiguous size as no reference is provided.

Now lets have a look at an object that represents all three of the previous geometric patterns. Even with one-half inch graph paper on it, the specific measurements are difficult to determine.

Within the Evidence Mapping Cube, we could tell you its dimensions relative to its geometric silloette views or even determine circumference, area or volume using standard formulae.

The Evidence Mapping Cube is only effective if it has been arranged properly and the subject has been properly illuminated. The learner should work with his simulation model and subject and position his eye as the camera position. The penlights should illustrate how lighting is to be arranged. A hinged pair of opaque cards are included to assist in the arrangement of the lights prior to placing an object in the cube. The audio tape should be stopped as needed so that practice with the simulation model will reinforce the concepts presented.

First, position the open cube on a table so that from an elevated viewpoint you are looking down into the open corner. Set the cardboard walls to complete the front sides of the enclosure. When the eye can peak over the enclosure and see the inside corner of the cube superimposed over the top front corner of the cardboard walls--you are viewing at

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a zero perspective, and a 45 degree elevation. This position is always used for every EMC image. When a camera on a tripod is used be sure to fill the frame as much as possible to provide adequate image detail.

Next, the lights are placed along an imaginary axle that passes from the source of illumination through the center hole on the cardboard wall and passes through the back wall of the Mapping Cube. Likewise, the second light is placed to illuminate the second side of the cube. Only when the shaft of light passes through both the cardboard wall and the wall of the cube, will the lights be properly placed. Their distance from the cube should be the same and the further the distance the better(within practical liminations of space and brightness). The cardboard walls may now be removed.

The brightness of the cube walls will "fool" a light meter resulting in under-exposed images. A more accurate exposure determination is achieved by metering from a medium grey card placed in the center of the cube. If the lighting is not changed; this exposure will remain the same for all evidence placed in the cube. Because a tripod will be used, the shutter speed is less important than the aperature. The smallest practical aperature will give the greatest depth of focus. The light intensity with most films should allow the photographer to use his smallest lens aperature.

Generally speaking, an object syhould be placed on the center of the cube's base and rotated to reveal primary

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surface details to the camera and relavent side and end shadow projections on the respective walls of the cube. Observe that the shadow height is the same on both walls and is equal to the actual height of the subject. Such an error demonstrates that one or both of the axial lights is not properly positioned.

The finished image should have uniform sharpness and even illumination. A high level of contrast is beneficial to define projected silloettes on the respective walls. If color were a signifigant attribute of the object, either negative or slide film could be used with a "tungstein " light balance.

The equilateral pyramid could be deceptive from nearly any angle; but within the cube we see that all sides are equal, and symetrical.

With a cube that is graphically marked in one-half inch squares, we can see that the cube is 3 inches wide; 3 inches long; and 3 inches high. Had the cube not been graphed, we would have been able to observe these same measurements on the base and the two walls of the Mapping Cube. The volume of the object photogrphed is thus length times width times height, or 9 cubic inches. Isn't that almost too easy?

This time we see a cylinder with a half inch grid wraping. It appears to have a width or diameter of 2.5 inches and a length of 5.25 inches. If we choose to determine volume we could use the formula provided: $V=ii*r2_{*h}$.

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...But note that the calculated length by tape measure is actually 5 inches exactly. Perhaps the lighting was not axial as it should be or the light to subject distance was so short as to enlarge the shadow on the background. If the image is to be fair and accurate; then the photographer must be sure to check his technique carefully.

The soda can is once again placed in the EMC and a more accurate shadow projection confirms the height to be 5 inches.

A symetrical object like a golf ball is an easy subject as it will appear the same no matter how it is placed in the cube and it is described by only a single measurement--its diameter. The vannila bottle seems to have a definite height and a definite thickness, but its width varies relative to the height at which it is measured. Illustrated in the Evidence Mapping Cube, the bottle is neatly positioned to illustrate its graceful curves with sufficient detail for an artist to recreate it in the absence of the origional object.

How large a box would be needed to wrap this film canister?.....
.....IT WOULD NEED TO BE AT LEAST 2 INCHES TALL AND COULD BE 1 AND ONE-HALF INCHES SQUARE.

Very good! ...Kodak was conservative and designed the box a little taller than was necessary.

With this plastic block, we get the signifigant information in the cube...

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...but as the design of the block allows us to open it; it might give us further information to illustrate it more completely this way.

The photograph of this small jar could depict the diameter of the jar lid, or clearly identify how much material remained in the jar by a study of the projected shadows.

A container of bath talc provides another sample of some household products that you might sharpen your skill with. As your level of competence increases; your desire for accuracy may lead you to refine the grid scale to centimeters or perhaps a one-quarter inch grid scale.

Not only in the area of criminal justice are such images as these important... when blueprints, silloette views, numerous dimension specifications and photographs from various angles are all necessary to describe an unfamiliar object--perhaps this EMC image will reduce the need for supplemental images or data; or at least clarify the supplemnental materials.

This camera is reasonably illustrated. Some people get all the information about it from a glance. A few might be interested in the specific spacing of the lenses and their relative diameters. An individual can extract as much information as the viewer would like in as much time as the viewer chooses to spend with the image.

This insense burner is a rather unique antique of interest to collectors. The image illustrates the article

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quite well with little need to includee a great deal of specifications other than the weight, the alloy, and discription of the interior.

This mug is a unique casting which is not a symetrical design. Should the handle need replacement or repair, this image would be a most helpful illustraton to the silversmith.

Paul Wohlfeil encourages you to try this technique of illustrating the three-dimensional subject. The cube enclosed in the module can be used with objects smaller than 6 inches; but you could certainly construct larger cubes to suit your photographic needs.

Paul's goal has been to utilize the power of the visual to provide as much information in the image with valid and repeatable success, using the conventional equipment available to the photographer.

Paul Wohlfeil would be most happy to hear from you if you should have any questions or comments concerning the contents of this program.

PAUL WOHLFEIL

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ORDER OF SLIDES

1. FOCUS
2. PREPARATIONS
3. LG. SHAKER BOX(NO REFERENCE)
4. SMALL SHAKER BOX(NO REFERENCE)
5. SMALL SHAKER BOX(W/RULER)
6. SMALL SHAKER BOX(IN MAPPING CUBE)
7. TWO-DIMENSIONAL SUBJECTS
8. 2-D FLAT PERSPECTIVE
9. CAMERA ARRANGEMENT
10. FINGERPRINT(W/ CM. RULER)
11. KEY W/ GRAPH PAPER
12. GUN W/ RULER
13. KNIFE W/ RULER
14. 2-D OBLIQUE PERSPECTIVE
15. THE CAMERA SET-UP
16. THE PHOTOGRAMETRY CARDS
17. 3 POINT PERSPECTIVE DRAWING
18. PHOTO W/GRID MAPPING
19. RECONSTRUCTED OVERHEAD VIEW
20. THREE-DIMENSIONAL SUBJECTS
21. EVIDENCE MAPPING CUBE
22. SUBJECTS W/O REFERENCES
23. FLAT VIEWS OF GEOMETRICAL PATTERNS

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24. A HAND-HELD AMBIGUOUS SUBJECT

25. AMBIGUOUS OBJECT IN THE EMC

26. SET-UP OF CUBE

27. LEFT AXIAL LIGHT

28. RIGHT AXIAL VIEW

29. GREY CARD

30. CAMERA POSITION

31. SIDE-VIEW OF ARRANGEMENT

32. RESULT OF EMC TECHNIQUE(BOTTLE)

33. AN EQUILATERAL PYRAMID

34. SQUARE CUBE W/VOLUME FORMULA

35. CYLINDER W/ VOLUME FORMULA

36. SODA CAN W/ MEASURING TAPE(LENGTH)

37. SODA CAN W/ MEASURING TAPE(CIRCUMFERENCE)

38. SODA CAN IN MAPPING CUBE

39. VANNILA BOTTLE AND GOLF BALL

40. GOLF BALL IN CUBE

41. VANNILA BOTTLE W/ RULER(LENGTH)

42. VANNILA BOTTLE W/ RULER(WIDTH)?

43. VANNILA BOTTLE IN CUBE

44. FILM CANISTER IN CUBE

45. FILM BOX IN CUBE

46. CHILD'S BUILDING BLOCK

47. BUILDING BLOCK OPEN ILLUSTRATION

48. SMALL JAR

49. CYLINDER OF TALC

50. NIMSLO CAMERA

51. BRASS INSENCE BURNER

52. DRINKING MUG

53. PAUL WOHLFEIL W/EMC ARRANGEMENT

54. CORRESPONDENCE CARD

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